US 20160300050A1

(19) United States
(12) Patent Application Publication
Hecht et al.
(10) Pub. No.: US 2016/0300050 A1
(43) Pub. Date: Oct. 13, 2016

(54) **VERIFYING A USER WITH BIOMETRIC DATA**

(71) Applicant: **GM Global Technology Operations LLC**, Detroit, MI (US)

(72) Inventors: **Ron M. Hecht**, Raanana (IL); **Omer Tsimhoni**, Ramat Hasharon (IL); **Xufang Zhao**, Windsor (CA); **Gaurav Talwar**, Novi, MI (US)

(73) Assignee: **GM Global Technology Operations LLC**, Detroit, MI (US)

(21) Appl. No.: **14/288,669**

(22) Filed: **May 28, 2014**

Publication Classification

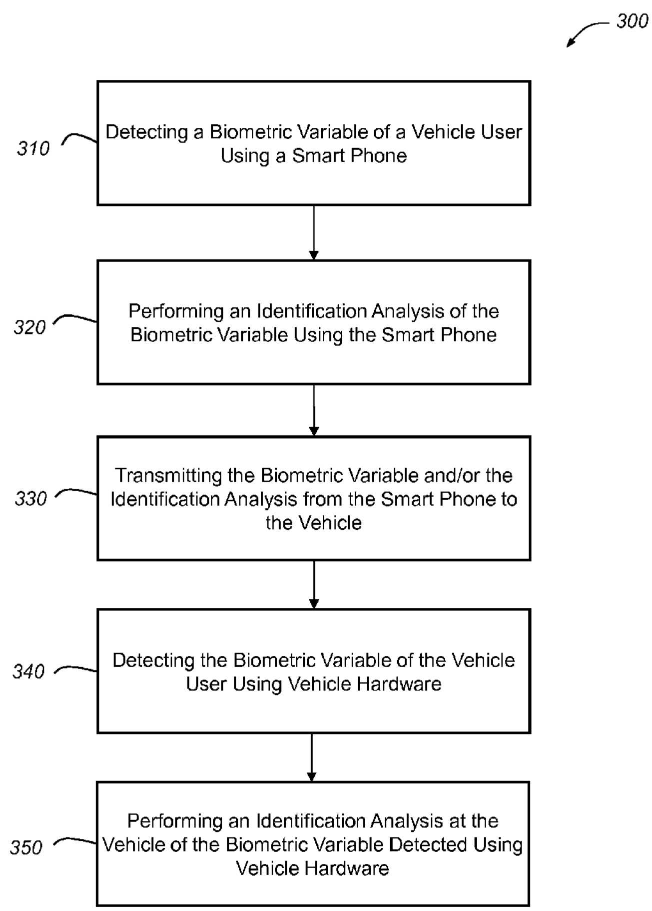
(51) **Int. Cl.**

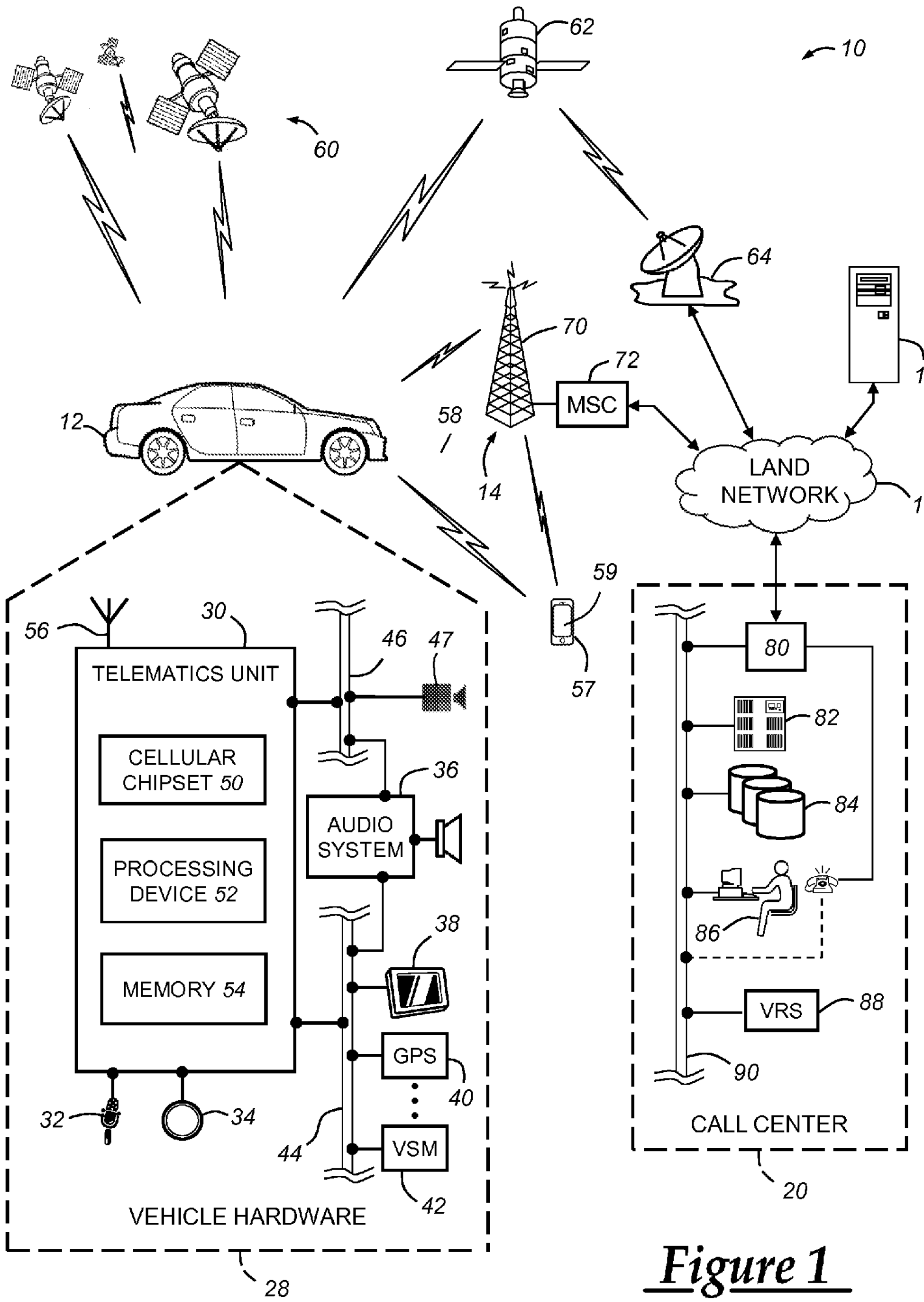
G06F 21/32	(2006.01)
H04W 12/08	(2006.01)
G10L 17/00	(2006.01)
H04W 12/06	(2006.01)
G06K 9/00	(2006.01)

(52) **U.S. Cl.**
CPC ***G06F 21/32*** (2013.01); ***H04W 12/06*** (2013.01); ***G06K 9/00288*** (2013.01); ***G10L 17/005*** (2013.01); ***H04W 12/08*** (2013.01)

(57) **ABSTRACT**

A system and method of verifying a biometric variable of a handheld wireless device user includes: receiving at a wireless device a biometric variable measured using a handheld wireless device; detecting the biometric variable at the wireless device in response to receiving the biometric variable measured using the handheld wireless device; performing feature recognition at the wireless device on the detected biometric variable; comparing the feature recognition performed at the wireless device with the biometric variable measured using the handheld wireless device; permitting access to one or more features available at the wireless device or the handheld wireless device when the comparison is within a predetermined range of values; and denying access to the wireless device or the handheld device when the comparison is outside of the predetermined range of values.





62
10
60
64
70
72
MSC
18
12
58
14
LAND NETWORK
16
59
57
30
56
TELEMATICS UNIT
46
47
CELLULAR CHIPSET 50
36
PROCESSING DEVICE 52
AUDIO SYSTEM
MEMORY 54
38
GPS
40
VSM
42
44
32
34
VEHICLE HARDWARE
28
80
82
84
86
VRS
88
90
CALL CENTER
20

Figure 1

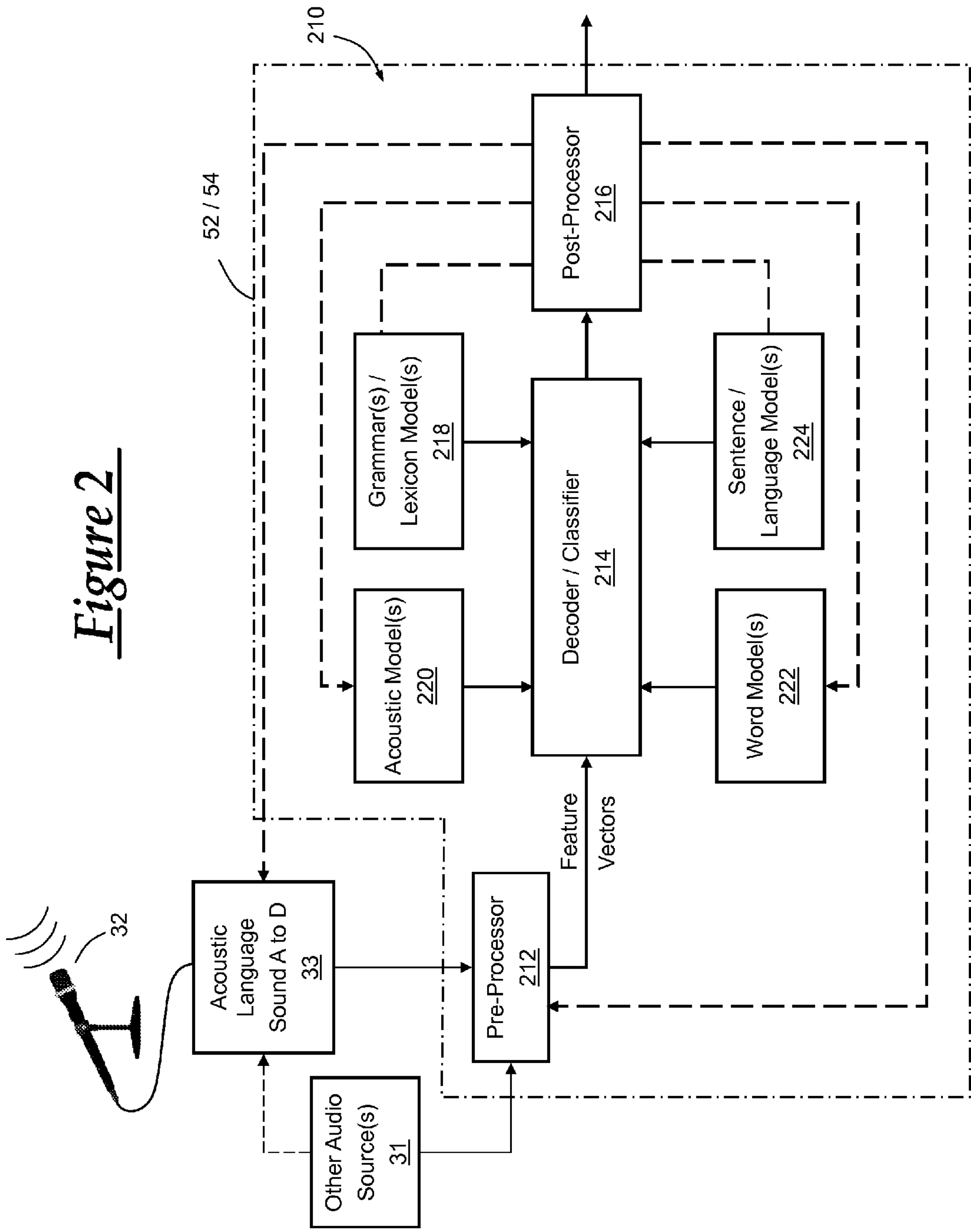

210
52 / 54
32
Acoustic Language Sound A to D 33
Other Audio Source(s) 31
Pre-Processor 212
Feature Vectors
Decoder / Classifier 214
Post-Processor 216
Acoustic Model(s) 220
Grammar(s) / Lexicon Model(s) 218
Word Model(s) 222
Sentence / Language Model(s) 224

Figure 2

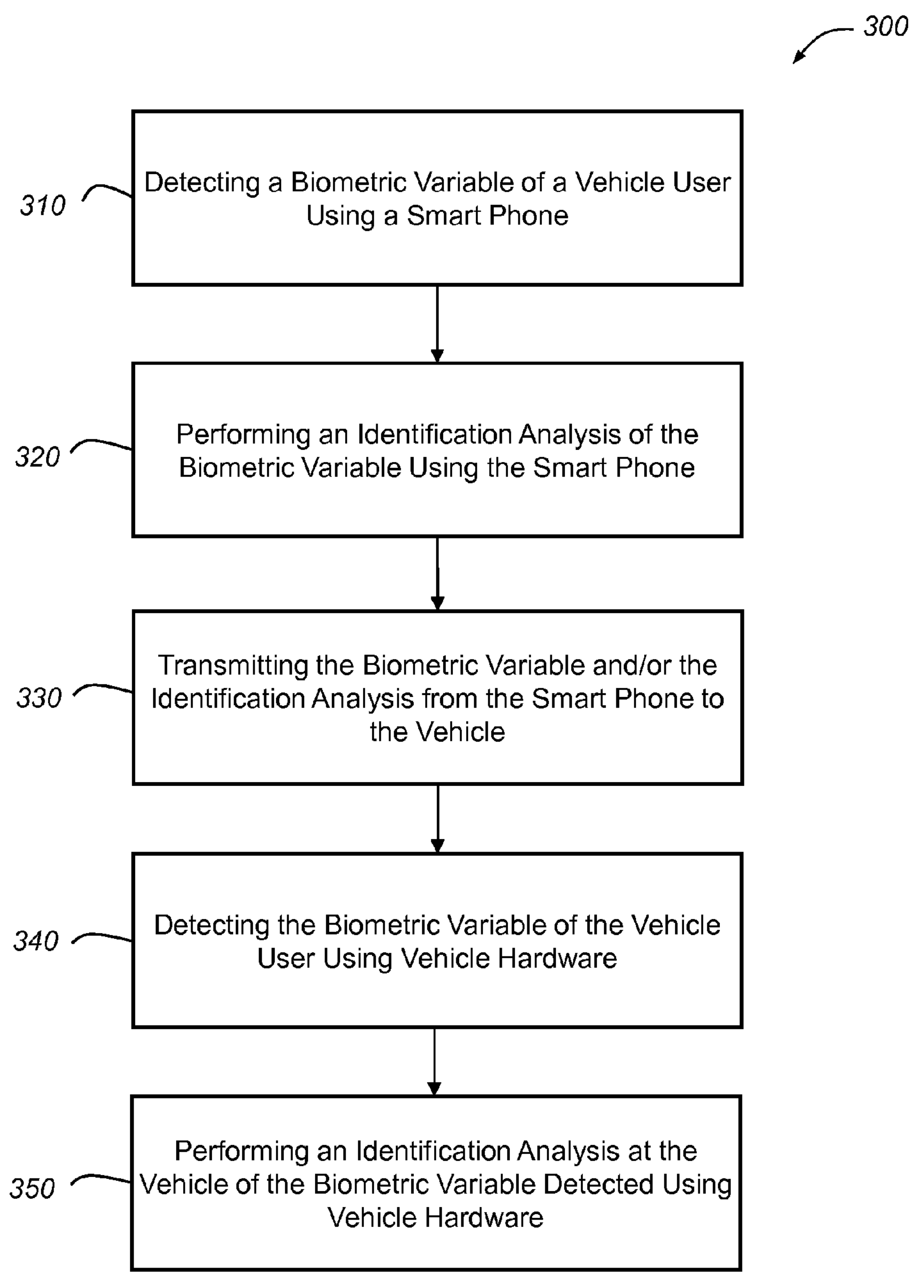

300
310
Detecting a Biometric Variable of a Vehicle User Using a Smart Phone
320
Performing an Identification Analysis of the Biometric Variable Using the Smart Phone
330
Transmitting the Biometric Variable and/or the Identification Analysis from the Smart Phone to the Vehicle
340
Detecting the Biometric Variable of the Vehicle User Using Vehicle Hardware
350
Performing an Identification Analysis at the Vehicle of the Biometric Variable Detected Using Vehicle Hardware

Figure 3

VERIFYING A USER WITH BIOMETRIC DATA

TECHNICAL FIELD

[0001] The present invention relates to verifying biometric variables, and more particularly to verifying biometric variables that are measured using more than one wireless device.

BACKGROUND

[0002] Wireless devices are carried by an ever-increasing number of users. As users carry the wireless devices for extended periods of time, the devices store larger amounts of sensitive information. In some cases, the wireless devices implement a mechanism to authenticate the users of the devices and prevent unauthorized access of the sensitive information. While passwords have been used to prevent unauthorized access, more sophisticated techniques have supplanted the use of passwords and involve verifying the biometric features or variables of the user, such as their appearance or voice, before granting access. However, the accuracy with which wireless devices identify these biometric variables may not be high enough for certain applications. As a result, it would be helpful to increase the accuracy of user authentication using biometric variables.

SUMMARY

[0003] According to an embodiment, there is provided a method of verifying a biometric variable of a handheld wireless device user. The method includes receiving at a wireless device a biometric variable measured using a handheld wireless device; detecting the biometric variable at the wireless device in response to receiving the biometric variable measured using the handheld wireless device; performing feature recognition at the wireless device on the detected biometric variable; comparing the feature recognition performed at the wireless device with the biometric variable measured using the handheld wireless device; permitting access to one or more features available at the wireless device or the handheld wireless device when the comparison is within a predetermined range of values; and denying access to the wireless device or the handheld device when the comparison is outside of the predetermined range of values

[0004] According to another embodiment, there is provided a method of verifying a biometric variable of a vehicle user. The method includes receiving at a vehicle a biometric variable measured using a handheld wireless device; detecting the biometric variable at the vehicle in response to receiving the biometric variable measured using the handheld wireless device; performing feature recognition at the vehicle on the detected biometric variable; comparing the feature recognition performed at the vehicle with the biometric variable measured using the handheld wireless device; permitting access to one or more vehicle features when the comparison is within a predetermined range of values; and denying access to the one or more vehicle features when the comparison is outside of the predetermined range of values.

[0005] According to yet another embodiment, there is provided a method of verifying a biometric variable of a vehicle user. The method includes detecting a biometric variable of the vehicle user using a handheld wireless device; performing an identification analysis of the biometric variable using the handheld wireless device; wirelessly transmitting the detected biometric variable, the identification analysis, or both to a vehicle; receiving the biometric variable, the identification analysis, or both at the vehicle; detecting the biometric variable of the vehicle user using vehicle hardware; performing an identification analysis at the vehicle of the biometric variable detected using vehicle hardware; and comparing the identification analysis performed at the vehicle to the received biometric variable, the received identification analysis, or both.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] One or more embodiments of the invention will hereinafter be described in conjunction with the appended drawings, wherein like designations denote like elements, and wherein:

[0007] FIG. **1** is a block diagram depicting an embodiment of a communications system that is capable of utilizing the method disclosed herein;

[0008] FIG. **2** is a block diagram depicting an embodiment of an automatic speech recognition system (ASR); and

[0009] FIG. **3** is a flow chart depicting an embodiment of a method of verifying a biometric variable of a vehicle user.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0010] The system and method described below verifies a user of a handheld wireless device or a user of a vehicle based on the analysis of both a full detector system and a simple verification system. The full detector system can be implemented at a handheld wireless device and measure a biometric variable of the user, such as the features of a face or the sound of a voice, and attempt to determine the user's identity by analyzing this measurement with respect to a previously-measured biometric variable of the user. When relied on alone, these measurements made by the full detector system may not always correctly identify the user. For instance, the full detector system may not only fail to allow access when it should, the system may also allow access when it should not. Even though such a failure may occur only once in 500 measurements of biometric variables, this rate may be unacceptable to adequately secure a vehicle or handheld device.

[0011] This failure rate can be reduced by transmitting the biometric variable measured by the full detector system to the simple verification system. The full detector system can be implemented as a more complex mechanism for authenticating a user via a biometric variable relative to the mechanism used by the simple verification system. One way the full verification system differs from the simple verification system is that it measures many more data points of the biometric variable as part of authorization and performs a more in-depth analysis regarding whether the measured biometric variable matches a previously-measured biometric variable. When measuring the biometric variable of an unknown user, the full detector system can consume significant processing capability as the system carefully analyzes the unknown user. In contrast, the simple verification system can confirm the analysis of the full detector by receiving the analysis of the full detector (i.e., that the user has been authorized) and the biometric variable measurement from the full detector. The simple verification system can then extract a subset of the data points analyzed by the full detector from the received biometric variable measurement, compare those extracted data points to those data points in its own measurement of the biometric variable, and confirm the analysis of the full detector. The simple verification system then agrees or disagrees with the analysis generated by the full detector system. If the simple verification system knows that the full detector system has confirmed the identity of the user, the relatively small number of data points analyzed by the simple verification system can confirm the results of the full detector system. By performing a more cursory analysis of the biometric variable and relying on the results of the full detector system, the simple verifier can more simply and economically implement a security system. The simple verifier can also increase the accuracy of the full detector system.

[0012] With reference to FIG. **1**, there is shown an operating environment that comprises a mobile vehicle communications system **10** and that can be used to implement the method disclosed herein. Communications system **10** generally includes a vehicle **12**, one or more wireless carrier systems **14**, a land communications network **16**, a computer **18**, and a call center **20**. It should be understood that the disclosed method can be used with any number of different systems and is not specifically limited to the operating environment shown here. Also, the architecture, construction, setup, and operation of the system **10** and its individual components are generally known in the art. Thus, the following paragraphs simply provide a brief overview of one such communications system **10**; however, other systems not shown here could employ the disclosed method as well.

[0013] Vehicle **12** is depicted in the illustrated embodiment as a passenger car, but it should be appreciated that any other vehicle including motorcycles, trucks, sports utility vehicles (SUVs), recreational vehicles (RVs), marine vessels, aircraft, etc., can also be used. Some of the vehicle electronics **28** is shown generally in FIG. **1** and includes a telematics unit **30**, a microphone **32**, one or more pushbuttons or other control inputs **34**, an audio system **36**, a visual display **38**, and a GPS module **40** as well as a number of vehicle system modules (VSMs) **42**. Some of these devices can be connected directly to the telematics unit such as, for example, the microphone **32** and pushbutton(s) **34**, whereas others are indirectly connected using one or more network connections, such as a communications bus **44** or an entertainment bus **46**. Examples of suitable network connections include a controller area network (CAN), a media oriented system transfer (MOST), a local interconnection network (LIN), a local area network (LAN), and other appropriate connections such as Ethernet or others that conform with known ISO, SAE and IEEE standards and specifications, to name but a few.

[0014] Telematics unit **30** can be an OEM-installed (embedded) or aftermarket device that is installed in the vehicle and that enables wireless voice and/or data communication over wireless carrier system **14** and via wireless networking. This enables the vehicle to communicate with call center **20**, other telematics-enabled vehicles, or some other entity or device. The telematics unit preferably uses radio transmissions to establish a communications channel (a voice channel and/or a data channel) with wireless carrier system **14** so that voice and/or data transmissions can be sent and received over the channel. By providing both voice and data communication, telematics unit **30** enables the vehicle to offer a number of different services including those related to navigation, telephony, emergency assistance, diagnostics, infotainment, etc. Data can be sent either via a data connection, such as via packet data transmission over a data channel, or via a voice channel using techniques known in the art. For combined services that involve both voice communication (e.g., with a live advisor or voice response unit at the call center **20**) and data communication (e.g., to provide GPS location data or vehicle diagnostic data to the call center **20**), the system can utilize a single call over a voice channel and switch as needed between voice and data transmission over the voice channel, and this can be done using techniques known to those skilled in the art.

[0015] According to one embodiment, telematics unit **30** utilizes cellular communication according to either GSM or CDMA standards and thus includes a standard cellular chipset **50** for voice communications like hands-free calling, a wireless modem for data transmission, an electronic processing device **52**, one or more digital memory devices **54**, and a dual antenna **56**. It should be appreciated that the modem can either be implemented through software that is stored in the telematics unit and is executed by processor **52**, or it can be a separate hardware component located internal or external to telematics unit **30**. The modem can operate using any number of different standards or protocols such as EVDO, CDMA, GPRS, and EDGE. Wireless networking between the vehicle and other networked devices can also be carried out using telematics unit **30**. For this purpose, telematics unit **30** can be configured to communicate wirelessly according to one or more wireless protocols, such as any of the IEEE 802.11 protocols, WiMAX, or Bluetooth. When used for packet-switched data communication such as TCP/IP, the telematics unit can be configured with a static IP address or can set up to automatically receive an assigned IP address from another device on the network such as a router or from a network address server.

[0016] One of the networked devices that can communicate with the telematics unit **30** is a handheld wireless device, such as a smart phone **57**. The smart phone **57** can include computer processing capability, a transceiver capable of communicating using a short-range wireless protocol, a microphone for receiving speech, one or more digital cameras capable of capturing still photographs and video, and a visual smart phone display **59**. In some implementations, the smart phone display **59** also includes a touch-screen graphical user interface and/or a GPS module capable of receiving GPS satellite signals and generating GPS coordinates based on those signals. Examples of the smart phone **57** include the iPhone™ manufactured by Apple, Inc. and the Android™ manufactured by a number of other smart phone producers. While the smart phone **57** may include the ability to communicate via cellular communications using the wireless carrier system **14**, this is not always the case. For instance, Apple manufactures devices such as the various models of the iPad™ and iPod Touch™ that include the processing capability, the display **59**, and the ability to communicate over a short-range wireless communication link. However, the iPod Touch™ and some iPads™ do not have cellular communication capabilities. Even so, these and other similar devices may be used or considered a type of handheld wireless device, such as the smart phone **57**, for the purposes of the method described herein. And it should also be appreciated that the wireless device need not necessarily be handheld to be used with the system and method(s) described herein. For instance, a wide variety of devices, such as televisions and vending machines, have become enabled with wireless communications technologies that can be cellular or short-range.

[0017] Processor **52** can be any type of device capable of processing electronic instructions including microprocessors, microcontrollers, host processors, controllers, vehicle communication processors, and application specific integrated circuits (ASICs). It can be a dedicated processor used only for telematics unit **30** or can be shared with other vehicle systems. Processor **52** executes various types of digitally-stored instructions, such as software or firmware programs stored in memory **54**, which enable the telematics unit to provide a wide variety of services. For instance, processor **52** can execute programs or process data to carry out at least a part of the method discussed herein.

[0018] Telematics unit **30** can be used to provide a diverse range of vehicle services that involve wireless communication to and/or from the vehicle. Such services include: turn-by-turn directions and other navigation-related services that are provided in conjunction with the GPS-based vehicle navigation module **40**; airbag deployment notification and other emergency or roadside assistance-related services that are provided in connection with one or more collision sensor interface modules such as a body control module (not shown); diagnostic reporting using one or more diagnostic modules; and infotainment-related services where music, webpages, movies, television programs, videogames and/or other information is downloaded by an infotainment module (not shown) and is stored for current or later playback. The above-listed services are by no means an exhaustive list of all of the capabilities of telematics unit **30**, but are simply an enumeration of some of the services that the telematics unit is capable of offering. Furthermore, it should be understood that at least some of the aforementioned modules could be implemented in the form of software instructions saved internal or external to telematics unit **30**, they could be hardware components located internal or external to telematics unit **30**, or they could be integrated and/or shared with each other or with other systems located throughout the vehicle, to cite but a few possibilities. In the event that the modules are implemented as VSMs **42** located external to telematics unit **30**, they could utilize vehicle bus **44** to exchange data and commands with the telematics unit.

[0019] GPS module **40** receives radio signals from a constellation **60** of GPS satellites. From these signals, the module **40** can determine vehicle position that is used for providing navigation and other position-related services to the vehicle driver. Navigation information can be presented on the display **38** (or other display within the vehicle) or can be presented verbally such as is done when supplying turn-by-turn navigation. The navigation services can be provided using a dedicated in-vehicle navigation module (which can be part of GPS module **40**), or some or all navigation services can be done via telematics unit **30**, wherein the position information is sent to a remote location for purposes of providing the vehicle with navigation maps, map annotations (points of interest, restaurants, etc.), route calculations, and the like. The position information can be supplied to call center **20** or other remote computer system, such as computer **18**, for other purposes, such as fleet management. Also, new or updated map data can be downloaded to the GPS module **40** from the call center **20** via the telematics unit **30**.

[0020] Apart from the audio system **36** and GPS module **40**, the vehicle **12** can include other vehicle system modules (VSMs) **42** in the form of electronic hardware components that are located throughout the vehicle and typically receive input from one or more sensors and use the sensed input to perform diagnostic, monitoring, control, reporting and/or other functions. Each of the VSMs **42** is preferably connected by communications bus **44** to the other VSMs, as well as to the telematics unit **30**, and can be programmed to run vehicle system and subsystem diagnostic tests. As examples, one VSM **42** can be an engine control module (ECM) that controls various aspects of engine operation such as fuel ignition and ignition timing, another VSM **42** can be a powertrain control module that regulates operation of one or more components of the vehicle powertrain, and another VSM **42** can be a body control module that governs various electrical components located throughout the vehicle, like the vehicle's power door locks and headlights. According to one embodiment, the engine control module is equipped with on-board diagnostic (OBD) features that provide myriad real-time data, such as that received from various sensors including vehicle emissions sensors, and provide a standardized series of diagnostic trouble codes (DTCs) that allow a technician to rapidly identify and remedy malfunctions within the vehicle. As is appreciated by those skilled in the art, the above-mentioned VSMs are only examples of some of the modules that may be used in vehicle **12**, as numerous others are also possible.

[0021] Vehicle electronics **28** also includes a number of vehicle user interfaces that provide vehicle occupants with a means of providing and/or receiving information, including microphone **32**, pushbuttons(s) **34**, audio system **36**, visual display **38**, and camera **47**. As used herein, the term 'vehicle user interface' broadly includes any suitable form of electronic device, including both hardware and software components, which is located on the vehicle and enables a vehicle user to communicate with or through a component of the vehicle. Microphone **32** provides audio input to the telematics unit to enable the driver or other occupant to provide voice commands and carry out hands-free calling via the wireless carrier system **14**. For this purpose, it can be connected to an on-board automated voice processing unit utilizing human-machine interface (HMI) technology known in the art. The pushbutton(s) **34** allow manual user input into the telematics unit **30** to initiate wireless telephone calls and provide other data, response, or control input. Separate pushbuttons can be used for initiating emergency calls versus regular service assistance calls to the call center **20**. Audio system **36** provides audio output to a vehicle occupant and can be a dedicated, stand-alone system or part of the primary vehicle audio system. According to the particular embodiment shown here, audio system **36** is operatively coupled to both vehicle bus **44** and entertainment bus **46** and can provide AM, FM and satellite radio, CD, DVD and other multimedia functionality. This functionality can be provided in conjunction with or independent of the infotainment module described above. Visual display **38** is preferably a graphics display, such as a touch screen on the instrument panel or a heads-up display reflected off of the windshield, and can be used to provide a multitude of input and output functions. The camera **47** can be one or more digital cameras that are installed in the rear view mirror of the vehicle **12** or in a way that they are aimed at vehicle users approaching the vehicle **12**. While the camera

47 is shown as being connected to the vehicle telematics unit **30** via the entertainment bus **46**, it is possible that the camera **47** can alternatively be linked to the vehicle telematics unit **30** via the communications bus **44** or to the unit **30** directly. Various other vehicle user interfaces can also be used, as the interfaces of FIG. **1** are only an example of one particular implementation.

[0022] Wireless carrier system **14** is preferably a cellular telephone system that includes a plurality of cell towers **70** (only one shown), one or more mobile switching centers (MSCs) **72**, as well as any other networking components required to connect wireless carrier system **14** with land network **16**. Each cell tower **70** includes sending and receiving antennas and a base station, with the base stations from different cell towers being connected to the MSC **72** either directly or via intermediary equipment such as a base station controller. Cellular system **14** can implement any suitable communications technology, including for example, analog technologies such as AMPS, or the newer digital technologies such as CDMA (e.g., CDMA2000) or GSM/GPRS. As will be appreciated by those skilled in the art, various cell tower/base station/MSC arrangements are possible and could be used with wireless system **14**. For instance, the base station and cell tower could be co-located at the same site or they could be remotely located from one another, each base station could be responsible for a single cell tower or a single base station could service various cell towers, and various base stations could be coupled to a single MSC, to name but a few of the possible arrangements.

[0023] Apart from using wireless carrier system **14**, a different wireless carrier system in the form of satellite communication can be used to provide uni-directional or bi-directional communication with the vehicle. This can be done using one or more communication satellites **62** and an uplink transmitting station **64**. Uni-directional communication can be, for example, satellite radio services, wherein programming content (news, music, etc.) is received by transmitting station **64**, packaged for upload, and then sent to the satellite **62**, which broadcasts the programming to subscribers. Bi-directional communication can be, for example, satellite telephony services using satellite **62** to relay telephone communications between the vehicle **12** and station **64**. If used, this satellite telephony can be utilized either in addition to or in lieu of wireless carrier system **14**.

[0024] Land network **16** may be a conventional land-based telecommunications network that is connected to one or more landline telephones and connects wireless carrier system **14** to call center **20**. For example, land network **16** may include a public switched telephone network (PSTN) such as that used to provide hardwired telephony, packet-switched data communications, and the Internet infrastructure. One or more segments of land network **16** could be implemented through the use of a standard wired network, a fiber or other optical network, a cable network, power lines, other wireless networks such as wireless local area networks (WLANs), or networks providing broadband wireless access (BWA), or any combination thereof. Furthermore, call center **20** need not be connected via land network **16**, but could include wireless telephony equipment so that it can communicate directly with a wireless network, such as wireless carrier system **14**.

[0025] Computer **18** can be one of a number of computers accessible via a private or public network such as the Internet. Each such computer **18** can be used for one or more purposes, such as a web server accessible by the vehicle via telematics unit **30** and wireless carrier **14**. Other such accessible computers **18** can be, for example: a service center computer where diagnostic information and other vehicle data can be uploaded from the vehicle via the telematics unit **30**; a client computer used by the vehicle owner or other subscriber for such purposes as accessing or receiving vehicle data or to setting up or configuring subscriber preferences or controlling vehicle functions; or a third party repository to or from which vehicle data or other information is provided, whether by communicating with the vehicle **12** or call center **20**, or both. A computer **18** can also be used for providing Internet connectivity such as DNS services or as a network address server that uses DHCP or other suitable protocol to assign an IP address to the vehicle **12**.

[0026] Call center **20** is designed to provide the vehicle electronics **28** with a number of different system back-end functions and, according to the exemplary embodiment shown here, generally includes one or more switches **80**, servers **82**, databases **84**, live advisors **86**, as well as an automated voice response system (VRS) **88**, all of which are known in the art. These various call center components are preferably coupled to one another via a wired or wireless local area network **90**. Switch **80**, which can be a private branch exchange (PBX) switch, routes incoming signals so that voice transmissions are usually sent to either the live adviser **86** by regular phone or to the automated voice response system **88** using VoIP. The live advisor phone can also use VoIP as indicated by the broken line in FIG. **1**. VoIP and other data communication through the switch **80** is implemented via a modem (not shown) connected between the switch **80** and network **90**. Data transmissions are passed via the modem to server **82** and/or database **84**. Database **84** can store account information such as subscriber authentication information, vehicle identifiers, profile records, behavioral patterns, and other pertinent subscriber information. Data transmissions may also be conducted by wireless systems, such as 802.11x, GPRS, and the like. Although the illustrated embodiment has been described as it would be used in conjunction with a manned call center **20** using live advisor **86**, it will be appreciated that the call center can instead utilize VRS **88** as an automated advisor or, a combination of VRS **88** and the live advisor **86** can be used.

[0027] Turning now to FIG. **2**, there is shown an illustrative architecture for an ASR system **210** that can be used to enable the presently disclosed method. In general, a vehicle occupant vocally interacts with an automatic speech recognition system (ASR) for one or more of the following fundamental purposes: training the system to understand a vehicle occupant's particular voice; storing discrete speech such as a spoken nametag or a spoken control word like a numeral or keyword; or recognizing the vehicle occupant's speech for any suitable purpose such as voice dialing, menu navigation, transcription, service requests, vehicle device or device function control, or the like. Generally, ASR extracts acoustic data from human speech, compares and contrasts the acoustic data to stored subword data, selects an appropriate subword which can be concatenated with other selected subwords, and outputs the concatenated subwords or words for post-processing such as dictation or transcription, address book dialing, storing to memory, training ASR models or adaptation parameters, or the like.

[0028] ASR systems are generally known to those skilled in the art, and FIG. **2** illustrates just one specific illustrative ASR system **210**. The system **210** includes a device to receive speech such as the telematics microphone **32**, and an acoustic interface **33** such as a sound card of the telematics unit **30** having an analog to digital converter to digitize the speech into acoustic data. The system **210** also includes a memory such as the telematics memory **54** for storing the acoustic data and storing speech recognition software and databases, and a processor such as the telematics processor **52** to process the acoustic data. The processor functions with the memory and in conjunction with the following modules: one or more front-end processors or pre-processor software modules **212** for parsing streams of the acoustic data of the speech into parametric representations such as acoustic features; one or more decoder software modules **214** for decoding the acoustic features to yield digital subword or word output data corresponding to the input speech utterances; and one or more post-processor software modules **216** for using the output data from the decoder module(s) **214** for any suitable purpose.

[0029] The system **210** can also receive speech from any other suitable audio source(s) **31**, which can be directly communicated with the pre-processor software module(s) **212** as shown in solid line or indirectly communicated therewith via the acoustic interface **33**. The audio source(s) **31** can include, for example, a telephonic source of audio such as a voice mail system, or other telephonic services of any kind.

[0030] One or more modules or models can be used as input to the decoder module(s) **214**. First, grammar and/or lexicon model(s) **218** can provide rules governing which words can logically follow other words to form valid sentences. In a broad sense, a grammar can define a universe of vocabulary the system **210** expects at any given time in any given ASR mode. For example, if the system **210** is in a training mode for training commands, then the grammar model(s) **218** can include all commands known to and used by the system **210**. In another example, if the system **210** is in a main menu mode, then the active grammar model(s) **218** can include all main menu commands expected by the system **210** such as call, dial, exit, delete, directory, or the like. Second, acoustic model(s) **220** assist with selection of most likely subwords or words corresponding to input from the pre-processor module(s) **212**. Third, word model(s) **222** and sentence/language model(s) **224** provide rules, syntax, and/or semantics in placing the selected subwords or words into word or sentence context. Also, the sentence/language model(s) **224** can define a universe of sentences the system **210** expects at any given time in any given ASR mode, and/or can provide rules, etc., governing which sentences can logically follow other sentences to form valid extended speech.

[0031] According to an alternative illustrative embodiment, some or all of the ASR system **210** can be resident on, and processed using, computing equipment in a location remote from the vehicle **12** such as the call center **20**. For example, grammar models, acoustic models, and the like can be stored in memory of one of the servers **82** and/or databases **84** in the call center **20** and communicated to the vehicle telematics unit **30** for in-vehicle speech processing. Similarly, speech recognition software can be processed using processors of one of the servers **82** in the call center **20**. In other words, the ASR system **210** can be resident in the telematics unit **30**, distributed across the call center **20** and the vehicle **12** in any desired manner, and/or resident at the call center **20**.

[0032] First, acoustic data is extracted from human speech wherein a vehicle occupant speaks into the microphone **32**, which converts the utterances into electrical signals and communicates such signals to the acoustic interface **33**. A sound-responsive element in the microphone **32** captures the occupant's speech utterances as variations in air pressure and converts the utterances into corresponding variations of analog electrical signals such as direct current or voltage. The acoustic interface **33** receives the analog electrical signals, which are first sampled such that values of the analog signal are captured at discrete instants of time, and are then quantized such that the amplitudes of the analog signals are converted at each sampling instant into a continuous stream of digital speech data. In other words, the acoustic interface **33** converts the analog electrical signals into digital electronic signals. The digital data are binary bits which are buffered in the telematics memory **54** and then processed by the telematics processor **52** or can be processed as they are initially received by the processor **52** in real-time.

[0033] Second, the pre-processor module(s) **212** transforms the continuous stream of digital speech data into discrete sequences of acoustic parameters. More specifically, the processor **52** executes the pre-processor module(s) **212** to segment the digital speech data into overlapping phonetic or acoustic frames of, for example, 10-30 ms duration. The frames correspond to acoustic subwords such as syllables, demi-syllables, phones, diphones, phonemes, or the like. The pre-processor module(s) **212** also performs phonetic analysis to extract acoustic parameters from the occupant's speech such as time-varying feature vectors, from within each frame. Utterances within the occupant's speech can be represented as sequences of these feature vectors. For example, and as known to those skilled in the art, feature vectors can be extracted and can include, for example, vocal pitch, energy profiles, spectral attributes, and/or cepstral coefficients that can be obtained by performing Fourier transforms of the frames and decorrelating acoustic spectra using cosine transforms. Acoustic frames and corresponding parameters covering a particular duration of speech are concatenated into unknown test pattern of speech to be decoded.

[0034] Third, the processor executes the decoder module (s) **214** to process the incoming feature vectors of each test pattern. The decoder module(s) **214** is also known as a recognition engine or classifier, and uses stored known reference patterns of speech. Like the test patterns, the reference patterns are defined as a concatenation of related acoustic frames and corresponding parameters. The decoder module(s) **214** compares and contrasts the acoustic feature vectors of a subword test pattern to be recognized with stored subword reference patterns, assesses the magnitude of the differences or similarities therebetween, and ultimately uses decision logic to choose a best matching subword as the recognized subword. In general, the best matching subword is that which corresponds to the stored known reference pattern that has a minimum dissimilarity to, or highest probability of being, the test pattern as determined by any of various techniques known to those skilled in the art to analyze and recognize subwords. Such techniques can include dynamic time-warping classifiers, artificial intelligence techniques, neural networks, free phoneme recognizers, and/or probabilistic pattern matchers such as Hidden Markov Model (HMM) engines.

[0035] HMM engines are known to those skilled in the art for producing multiple speech recognition model hypotheses of acoustic input. The hypotheses are considered in ultimately identifying and selecting that recognition output which represents the most probable correct decoding of the acoustic input via feature analysis of the speech. More specifically, an HMM engine generates statistical models in the form of an "N-best" list of subword model hypotheses ranked according to HMM-calculated confidence values or probabilities of an observed sequence of acoustic data given one or another subword such as by the application of Bayes' Theorem.

[0036] A Bayesian HMM process identifies a best hypothesis corresponding to the most probable utterance or subword sequence for a given observation sequence of acoustic feature vectors, and its confidence values can depend on a variety of factors including acoustic signal-to-noise ratios associated with incoming acoustic data. The HMM can also include a statistical distribution called a mixture of diagonal Gaussians, which yields a likelihood score for each observed feature vector of each subword, which scores can be used to reorder the N-best list of hypotheses. The HMM engine can also identify and select a subword whose model likelihood score is highest.

[0037] In a similar manner, individual HMMs for a sequence of subwords can be concatenated to establish single or multiple word HMM. Thereafter, an N-best list of single or multiple word reference patterns and associated parameter values may be generated and further evaluated.

[0038] In one example, the speech recognition decoder **214** processes the feature vectors using the appropriate acoustic models, grammars, and algorithms to generate an N-best list of reference patterns. As used herein, the term reference patterns is interchangeable with models, waveforms, templates, rich signal models, exemplars, hypotheses, or other types of references. A reference pattern can include a series of feature vectors representative of one or more words or subwords and can be based on particular speakers, speaking styles, and audible environmental conditions. Those skilled in the art will recognize that reference patterns can be generated by suitable reference pattern training of the ASR system and stored in memory. Those skilled in the art will also recognize that stored reference patterns can be manipulated, wherein parameter values of the reference patterns are adapted based on differences in speech input signals between reference pattern training and actual use of the ASR system. For example, a set of reference patterns trained for one vehicle occupant or certain acoustic conditions can be adapted and saved as another set of reference patterns for a different vehicle occupant or different acoustic conditions, based on a limited amount of training data from the different vehicle occupant or the different acoustic conditions. In other words, the reference patterns are not necessarily fixed and can be adjusted during speech recognition.

[0039] Using the in-vocabulary grammar and any suitable decoder algorithm(s) and acoustic model(s), the processor accesses from memory several reference patterns interpretive of the test pattern. For example, the processor can generate, and store to memory, a list of N-best vocabulary results or reference patterns, along with corresponding parameter values. Illustrative parameter values can include confidence scores of each reference pattern in the N-best list of vocabulary and associated segment durations, likelihood scores, signal-to-noise ratio (SNR) values, and/or the like. The N-best list of vocabulary can be ordered by descending magnitude of the parameter value(s). For example, the vocabulary reference pattern with the highest confidence score is the first best reference pattern, and so on. Once a string of recognized subwords are established, they can be used to construct words with input from the word models **222** and to construct sentences with the input from the language models **224**.

[0040] Finally, the post-processor software module(s) **216** receives the output data from the decoder module(s) **214** for any suitable purpose. In one example, the post-processor software module(s) **216** can identify or select one of the reference patterns from the N-best list of single or multiple word reference patterns as recognized speech. In another example, the post-processor module(s) **216** can be used to convert acoustic data into text or digits for use with other aspects of the ASR system or other vehicle systems. In a further example, the post-processor module(s) **216** can be used to provide training feedback to the decoder **214** or pre-processor **212**. More specifically, the post-processor **216** can be used to train acoustic models for the decoder module (s) **214**, or to train adaptation parameters for the pre-processor module(s) **212**.

[0041] The method or parts thereof can be implemented in a computer program product embodied in a computer readable medium and including instructions usable by one or more processors of one or more computers of one or more systems to cause the system(s) to implement one or more of the method steps. The computer program product may include one or more software programs comprised of program instructions in source code, object code, executable code or other formats; one or more firmware programs; or hardware description language (HDL) files; and any program related data. The data may include data structures, look-up tables, or data in any other suitable format. The program instructions may include program modules, routines, programs, objects, components, and/or the like. The computer program can be executed on one computer or on multiple computers in communication with one another.

[0042] The program(s) can be embodied on computer readable media, which can be non-transitory and can include one or more storage devices, articles of manufacture, or the like. Exemplary computer readable media include computer system memory, e.g. RAM (random access memory), ROM (read only memory); semiconductor memory, e.g. EPROM (erasable, programmable ROM), EEPROM (electrically erasable, programmable ROM), flash memory; magnetic or optical disks or tapes; and/or the like. The computer readable medium may also include computer to computer connections, for example, when data is transferred or provided over a network or another communications connection (either wired, wireless, or a combination thereof). Any combination (s) of the above examples is also included within the scope of the computer-readable media. It is therefore to be understood that the method can be at least partially performed by any electronic articles and/or devices capable of carrying out instructions corresponding to one or more steps of the disclosed method.

[0043] Turning now to FIG. **3**, there is shown a method **300** of verifying a biometric variable of a vehicle user. The method **300** begins at step **310** by detecting a biometric variable of the vehicle user using a handheld wireless device. The handheld wireless device of method **300** will be described using the smart phone **57**. However, it should be appreciated that other types of handheld wireless devices could also be used successfully with the method **300**. And other wireless devices can be substituted for the vehicle **12** regardless of whether they are handheld or mobile. Furthermore, with respect to the method **300**, the smart phone **57** can act as a full detector system while the vehicle **12** or vehicle telematics unit **30** can act as a simple verification system. The biometric variable can be a measurement of a unique feature belonging to or produced by the human body that is quantifiable by one or more sensing features of the smart phone **57**. Biometric variables include the vehicle user's voice, facial features, signature, or fingerprints to name a few examples. The sensing features of the smart phone **57** can translate measurable aspects of the biometric variable into data points readable by the microprocessor of the smart phone **57**. The sensing features used by the smart phone **57** can depend on the type of biometric variable measured. For example, when detecting the facial features of the vehicle user, the smart phone **57** can use its camera to capture an image of the vehicle user. In another example, the smart phone **57** can use its microphone to receive speech from the vehicle user when analyzing the vehicle user's voice. The method **300** proceeds to step **320**.

[0044] At step **320**, an identification analysis of the biometric variable is performed using the smart phone **57**. Once the smart phone **57** has measured a biometric variable of the vehicle user, the smart phone **57** can then compare that biometric variable with a previously-stored biometric variable measurement to carry out feature recognition. The vehicle user can establish one or more previously-stored biometric variable measurements that can act as a baseline from which the smart phone **57** serves as a full detector system and compares the measured biometric variable with the previously-stored biometric variable measurement. The previously-stored biometric variable measurement can be stored at the smart phone **57** in one or more memory devices or could be accessed from a central facility, such as computer **18**. Using facial recognition as an example of the biometric variable measured, the smart phone **57** can access a previously-taken photograph of the vehicle user that can be used as the previously-stored biometric variable measurement. The smart phone **57** can then apply its full detector system to compare the biometric variable it measured to the previously-stored biometric variable measurement. Various software is available to implement such a comparison that can compare the measured biometric variable in the form of a photograph of a vehicle user's face taken by the smart phone **57** to the previously-stored biometric variable measurement (a previously-stored photograph of the vehicle user) and generate an identification analysis that indicates with a confidence percentage how likely it is that the two images match. As discussed above, the identification analysis carried out by the full detector system can compare a relatively large number of data points in the measured biometric variable to data points measured from the previously-stored biometric variable. In one implementation, 1000 or more data points from the measured biometric variable can be compared to the previously-stored biometric variable. The identification analysis carried out by the full detector can include a decision of whether the two images match, the confidence percentage, or both.

[0045] In another implementation, it is also possible to use a segment of speech recorded from the vehicle user as the previously-stored biometric variable measurement. The smart phone **57** can record speech received from a vehicle user and store it as the previously-stored biometric variable measurement. The speech can be stored in a pulse-code modulation (PCM) file, for example. The smart phone **57** can then receive speech from the vehicle user via a microphone and perform speech recognition on the received speech. The speech recognition can be carried out using an ASR system that is stored locally on the smart phone **57**. The ASR system can perform feature extraction from the recording that can be Cepstral-based, estimate the distribution of the features, transform the distributions into a single point in a high dimensional space (an array of feature values), and compare the single point to another point or other points that represent a base signature. This can include finding the distance between the two or more vectors/points. The ASR system can then compute distances to other vectors that represent other people, normalize the distances relative to other vectors in order to decide the likelihood that the compared point matches the base signature, and compare the results with a threshold that is based on one or more preset values for acceptance and rejection. It is also possible to wirelessly send speech received by the smart phone **57** to a central facility, such as a cloud-based computing system implemented as computer **18**, that performs ASR on the received speech, compares the speech received from the vehicle user to the previously-stored speech, and then returns the results to the smart phone **57**. The results from the ASR system can be included in an identification analysis that outputs a decision regarding whether the received speech matches the previously-stored speech, a confidence percentage of how likely it is that the received speech matches the previously-stored speech, or both. The method **300** proceeds to step **330**.

[0046] At step **330**, the detected biometric variable, the identification analysis, or both is wirelessly transmitted from the smart phone **57** to the vehicle **12**. The smart phone **57** can establish a short-range wireless communication link with the vehicle telematics unit **30** and send the biometric variable measured or detected using the smart phone **57** to the unit **30** along with the identification analysis performed by the smart phone **57**. The smart phone **57** can also send a computer-readable instruction alerting the vehicle **12** that the information sent over the short-range wireless communication link should be used for authentication purposes and may command the vehicle **12** to begin performing those services. The command to begin performing these services can also originate from the vehicle **12** for transmission to the smart phone **57**. The short-range wireless communication link can be carried out using any one of the short-range wireless communication protocols set forth in the IEEE 802.11 standards.

[0047] The vehicle **12** and the smart phone **57** can also authenticate the identity of each other. For instance, the smart phone **57**, acting as the full detector system, can inform the vehicle **12** using the simple verifier system that it has authenticated a user. The vehicle **12** may need to verify that the smart phone **57** is a trusted device before accepting the analysis and communications from the smart phone **57** as valid. This can be carried out using secret passwords, a trusted third party certificate verifier, or some other cryptographic techniques that are known. In addition, the vehicle

12 can communicate with several smart phones at once and be able to distinguish one smart phone from another. By receiving an identifier from each smart phone, the vehicle **12** can differentiate between the driver and the passengers, which can be helpful when several biometric sensors are in the vehicle **12** or even a single biometric sensor facing the driver. The method proceeds to step **340**.

[0048] At step **340**, the biometric variable of the vehicle user is detected using vehicle hardware. After receiving the biometric variable detected by the smart phone **57**, the identification analysis, or both, and the smart phone **57** has been authenticated as a trusted device, the vehicle **12** can measure the same biometric variable as measured by the smart phone **57** using one or more hardware elements on the vehicle **12**. For example, vehicle telematics unit **30** can receive an image of the vehicle user from the smart phone **57** as part of performing face recognition and the image can include a computer-readable instruction commanding the vehicle telematics unit **30** to verify the image with a photograph of the vehicle user taken using the camera **47** of the vehicle **12**. The vehicle **12** can use the processor **52** to determine that the computer-readable instruction included with the received biometric variable (in this case, the image) commands the vehicle **12** to take a photograph of the vehicle user. The vehicle user can then stand outside of the vehicle **12** and the camera **47** can capture an image of the vehicle user. In another example, the vehicle telematics unit **30** can receive recorded speech of the vehicle user as the biometric variable with the computer-readable instruction commanding the vehicle **12** to verify the speech recorded by the smart phone **57**. The vehicle **12** can then act on the computer-readable instruction to prompt the vehicle user to speak into the microphone **32**, which can be mounted on the interior or exterior of the vehicle **12**, so that the vehicle **12** can detect the biometric variable (i.e., speech) of the vehicle user. The method **300** proceeds to step **350**.

[0049] At step **350**, an identification analysis is performed at the vehicle **12** of the biometric variable detected using vehicle hardware. Once the vehicle **12** measures the biometric variable, the processor **52** of the vehicle telematics unit **30** can confirm the authentication determined by the smart phone **57** using the vehicle-measured biometric variable and the biometric variable sent from the smart phone **57**. Broadly speaking, the vehicle **12** can perform an analysis that is simpler than that which was performed by the smart phone **57**. The simple verifier system of the vehicle **12** can compare a subset of data from the measured biometric variable with a subset of data from the received biometric variable and confirm the result of the analysis carried out at the smart phone **57**, or full detector. Using voice as the biometric variable, the vehicle **12** can perform feature extraction from a recording (usually Cepstral based) and estimate the distribution of the features. The distribution of the features can be transformed into a single point in a high dimensional space (an array of feature values) and compared to another point or other points that represent a base signature of the received biometric variable thereby finding the distance between the two or more vectors/points.

[0050] Rather than using a previously-stored biometric variable of the user, the vehicle **12** can compare the biometric variable measured at the vehicle **12** to the biometric variable measured by the smart phone **57** and/or the identification analysis of the smart phone **57**. That way, the vehicle **12** may not need to rely on the previously-stored biometric variable of the user. When the biometric variable measured at the vehicle **12** is within a pre-determined range of values of the biometric variable measured by the smart phone **57** or the identification analysis of the smart phone **57**, the vehicle **12** can confirm the verification carried out at the smart phone **57** and provide access to the vehicle **12** or one or more vehicle functions. Conversely, when the biometric variable measured at the vehicle **12** is outside of the pre-determined range of values of the biometric variable measured by the smart phone **57**, the vehicle **12** can reject the identification analysis of the smart phone **57** and deny access to the vehicle **12** or one or more vehicle functions. Determining when the biometric variable measured at the vehicle **12** is within sufficient range of the biometric variable sent to the vehicle **12** can involve establishing a confidence value of greater than 1:1,000,000 chance of the two variables not matching. That is, if the chance of incorrectly determining that two variables match is greater than 1:1,000,000, the vehicle **12** can determine a match occurs and can permit access to vehicle functions such as door locks, vehicle starting, or infotainment use. Otherwise, the vehicle **12** can deny access to the vehicle functions.

[0051] It is to be understood that the foregoing is a description of one or more embodiments of the invention. The invention is not limited to the particular embodiment(s) disclosed herein, but rather is defined solely by the claims below. For example, the method **300** could also be carried out using two handheld wireless devices rather than the smart phone **57** and the vehicle **12**/vehicle telematics unit **30**. The handheld wireless devices could be the smart phone **57** as one handheld wireless device and another handheld wireless device in the form of a television remote control having ASR capability, a handheld tablet, or a video game console to provide a few examples of the different handheld wireless devices that could be used with the smart phone **57**. Each of these devices can measure a biometric variable of the user and authenticate a user with the measured biometric variables from both handheld wireless devices. Furthermore, the statements contained in the foregoing description relate to particular embodiments and are not to be construed as limitations on the scope of the invention or on the definition of terms used in the claims, except where a term or phrase is expressly defined above. Various other embodiments and various changes and modifications to the disclosed embodiment(s) will become apparent to those skilled in the art. All such other embodiments, changes, and modifications are intended to come within the scope of the appended claims.

[0052] As used in this specification and claims, the terms "e.g.," "for example," "for instance," "such as," and "like," and the verbs "comprising," "having," "including," and their other verb forms, when used in conjunction with a listing of one or more components or other items, are each to be construed as open-ended, meaning that the listing is not to be considered as excluding other, additional components or items. Other terms are to be construed using their broadest reasonable meaning unless they are used in a context that requires a different interpretation.

1. A method of verifying a biometric variable of a handheld wireless device user, comprising the steps of:

(a) receiving at a wireless device a biometric variable measured using a handheld wireless device;

(b) detecting the biometric variable at the wireless device in response to receiving the biometric variable measured using the handheld wireless device;

(c) performing feature recognition at the wireless device on the detected biometric variable;

(d) comparing the feature recognition performed at the wireless device with the biometric variable measured using the handheld wireless device;

(e) permitting access to one or more features available at the wireless device or the handheld wireless device when the comparison in step (d) is within a predetermined range of values; and

(f) denying access to the wireless device or the handheld device when the comparison in step (d) is outside of the predetermined range of values.

2. The method of claim **1**, further comprising the step of comparing the biometric variable measured using the handheld wireless device to a previously-stored biometric feature measurement of the handheld wireless device user.

3. The method of claim **1**, further comprising the step of receiving at the wireless device an identification analysis performed by the handheld wireless device.

4. The method of claim **1**, wherein the biometric variable further comprises a voice or a facial feature of the handheld wireless device user.

5. The method of claim **1**, wherein the wireless device further comprises a smart phone.

6. A method of verifying a biometric variable of a vehicle user, comprising the steps of:

(a) receiving at a vehicle a biometric variable measured using a handheld wireless device;

(b) detecting the biometric variable at the vehicle in response to receiving the biometric variable measured using the handheld wireless device;

(c) performing feature recognition at the vehicle on the detected biometric variable;

(d) comparing the feature recognition performed at the vehicle with the biometric variable measured using the handheld wireless device;

(e) permitting access to one or more vehicle features when the comparison in step (d) is within a predetermined range of values; and

(f) denying access to the one or more vehicle features when the comparison in step (d) is outside of the predetermined range of values.

7. The method of claim **6**, further comprising the step of comparing the biometric variable measured using the handheld wireless device to a previously-stored biometric feature measurement of the vehicle user.

8. The method of claim **6**, further comprising the step of receiving at the vehicle an identification analysis performed by the handheld wireless device.

9. The method of claim **6**, wherein the biometric variable further comprises a voice or a facial feature of the vehicle user.

10. The method of claim **6**, wherein the handheld wireless device further comprises a smart phone.

11. The method of claim **6**, further comprising the step of detecting the biometric variable at the vehicle using a camera or a microphone.

12. A method of verifying a biometric variable of a vehicle user, comprising the steps of:

(a) detecting a biometric variable of the vehicle user using a handheld wireless device;

(b) performing an identification analysis of the biometric variable using the handheld wireless device;

(c) wirelessly transmitting the detected biometric variable, the identification analysis, or both to a vehicle;

(d) receiving the biometric variable, the identification analysis, or both at the vehicle;

(e) detecting the biometric variable of the vehicle user using vehicle hardware;

(f) performing an identification analysis at the vehicle of the biometric variable detected using vehicle hardware; and

(g) comparing the identification analysis performed at the vehicle to the received biometric variable, the received identification analysis, or both.

13. The method of claim **12**, further comprising the step of comparing the biometric variable measured using the handheld wireless device to a previously-stored biometric feature measurement of the vehicle user.

14. The method of claim **12**, further comprising the step of receiving at the vehicle an identification analysis performed by the handheld wireless device.

15. The method of claim **12**, wherein the biometric variable further comprises a voice or a facial feature of the vehicle user.

16. The method of claim **12**, wherein the handheld wireless device further comprises a smart phone.

17. The method of claim **12**, further comprising the step of detecting the biometric variable at the vehicle using a camera or a microphone.

* * * * *